TERMINAL LEARNING OBJECTIVE

ACTION

Troubleshoot digital buffer and inverter circuits.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Logic Probe, Digital Multimeter w/test leads, PC130-106, PC130-112, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning digital buffer and inverter circuits.

CLASSIFICATION: UNCLASSFIED

SAFETY CONSIDERATIONS: ELECTRICAL SHOCK HAZARD

ELECTOSTATIC DISCHARGE

ENABLING LEARNING OBJECTIVE 1

ACTION

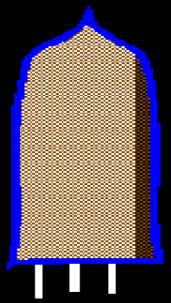
Define Digital Electronics, Integrated Circuits, Wave shapes, and Test Equipment

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Logic Probe, Digital Multimeter w/test leads, PC130-106, PC130-112, and official OMEMS reference material.

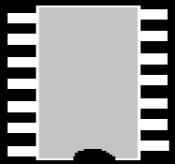
STANDARD

Correctly answer 18 of 25 questions concerning digital buffer and inverter circuits.



VACUUM TUBE
(FIRST GENERATION)

TRANSISTOR
(SECOND GENERATION)

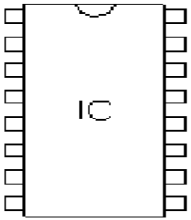


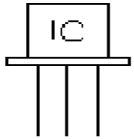
INTEGRATED CIRCUITRY
(THIRD GENERATION)

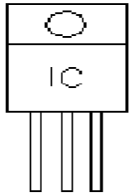
MINIATURIZATION
(FOURTH GENERATION)

DIGITAL- ELECTRONICS OF COUNTING

EL05-SS2

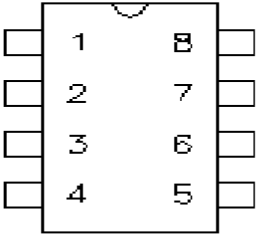




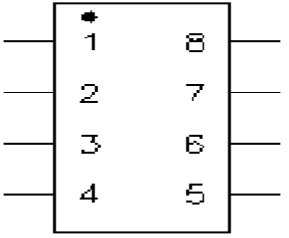


Integrated Circuits

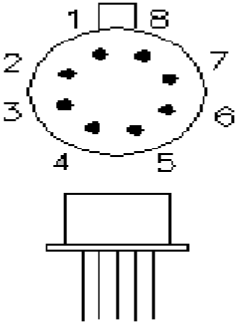
ELO5-S03



DIP



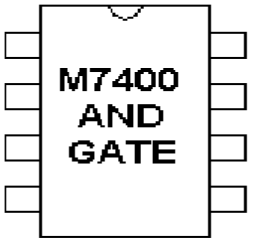
FLAT PACK

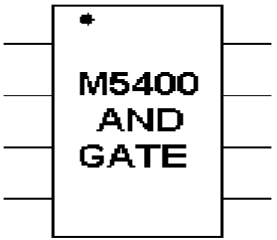


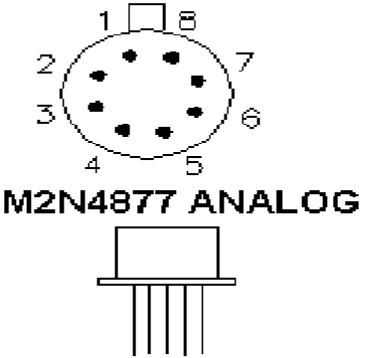
CANISTER

Integrated Circuit Cases Styles

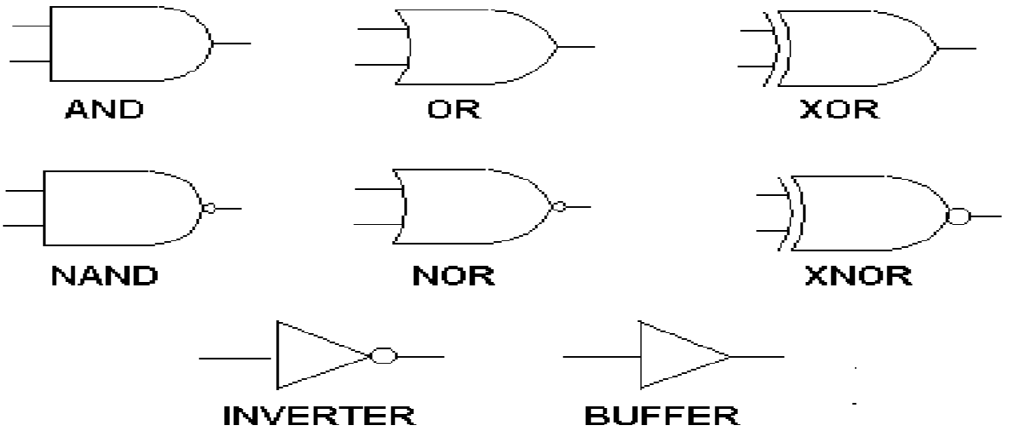
EL05-S04







PART/PIN NUMBER AND FUNCTION



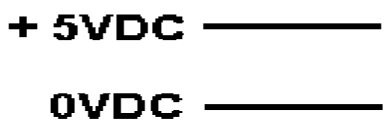
Integrated Circuit Logic Gates

ICs LEVELS OF INTEGRATION

SMALL SCALE (SSI)	LESS THAN 12 LOGIC GATES
MEDIUM SCALE (MSI)	12 TO 99 LOGIC GATES
LARGE SCALE (LSI)	100 TO 9,999 LOGIC GATES
VERY LARGE (VLSI)	10,000 - 99,999 LOGIC GATES
ULTRA LARGE (ULSI)	100,000 OR MORE GATES

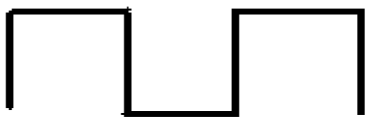
What would be the level of an integrated circuit that contained 15 digital logic gates?

1. VSLI
2. SSI
3. MSI
4. LSI



VOLTAGE LEVEL

PULSE WAVE

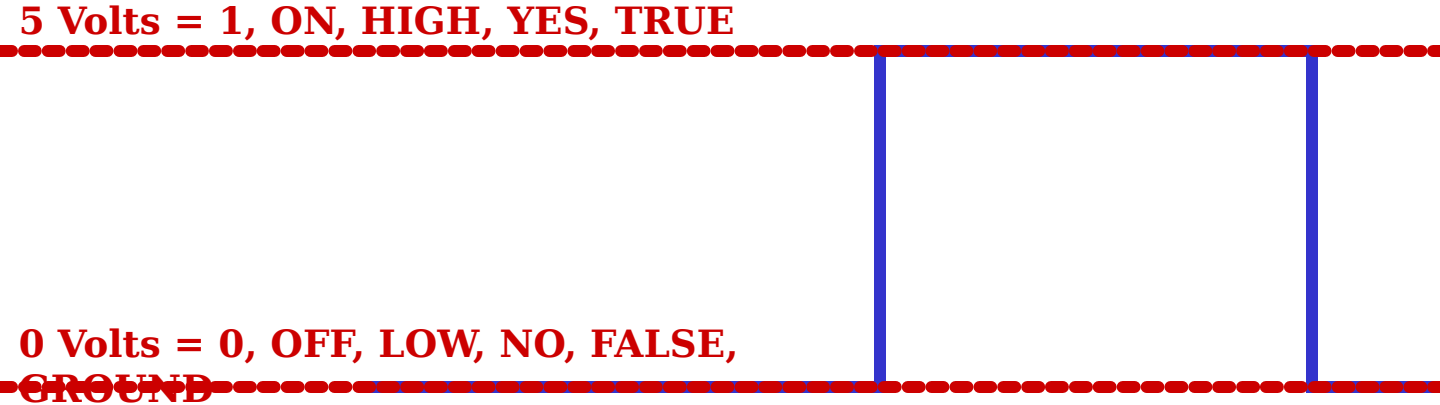


SQUARE WAVE

Integrated Circuits Waveshapes

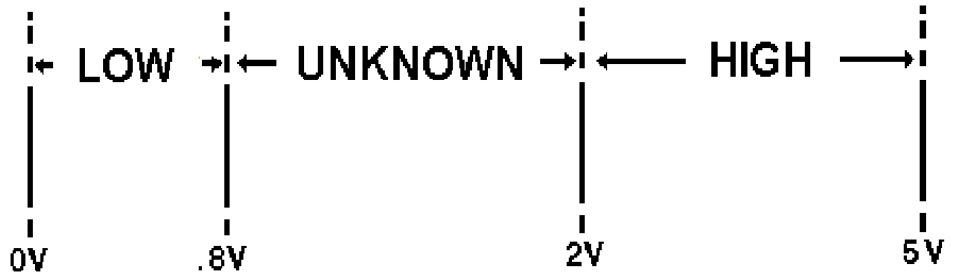
EL05-S08

Terminology



Positive Logic Levels

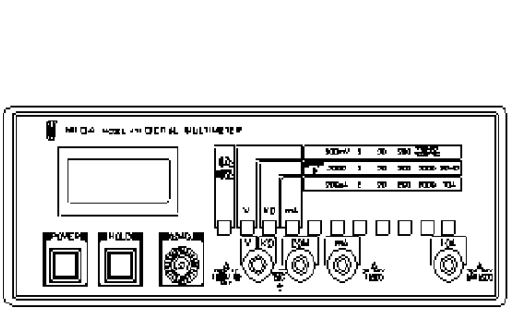
Two Conditions / States

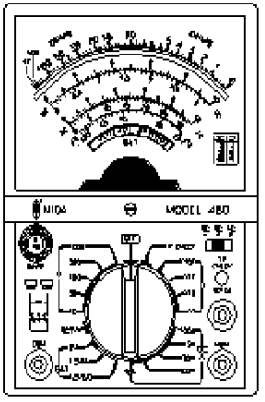


THRESHOLD VOLTAGES FOR
TTL INTEGRATED CIRCUITS

What in the most common type of digital logic in use today?

1. DTL
2. TTL
3. RTL
4. ECL





Multimeters

EL05-S11

Logic Probe

EL05-S13

On the Nida 2100 logic probe, what type of signal is indicated when the red LED is illuminated and others are extinguished?

1. LOW
2. PULSE
3. HIGH
4. SQUARE WAVE

ENABLING LEARNING OBJECTIVE 2

ACTION

Describe the operation of buffers and inverters.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Logic Probe, Digital Multimeter w/test leads, PC130-106, PC130-112, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning digital buffer and inverter circuits.

BUFFER

Common collector amplifier

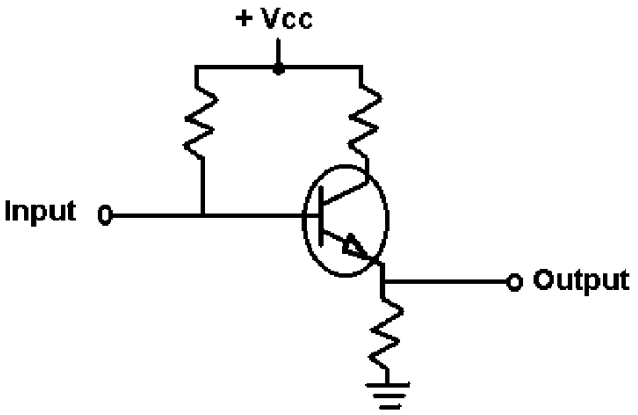
&

INVERTER

Common emmitter amplifier

BUFFER

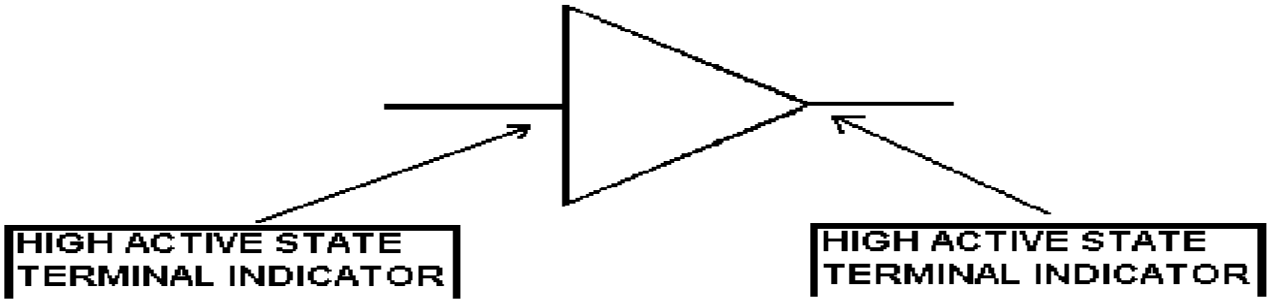
1. PROTECTION (HIGH INPUT VOLTAGE OR CURRENT)
2. DRIVER (MAINTAIN CURRENT LEVELS)
3. SWITCH (AMPLIFIER)



Common Collector Buffer

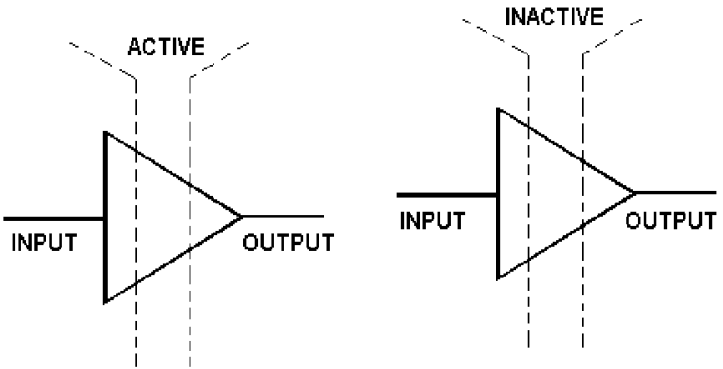
Note: Does not invert input signal. Emitter output VDC approximately .6VDC less than Base input

EL05-S17



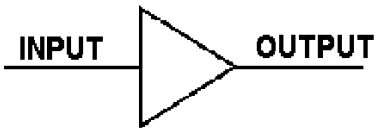
BUFFER SYMBOL & TERMINAL INDICATORS

LOGIC ELEMENT CONDITIONS



ACTIVE - VOLTAGE IS THE SAME AS THE TERMINAL INDICATOR.

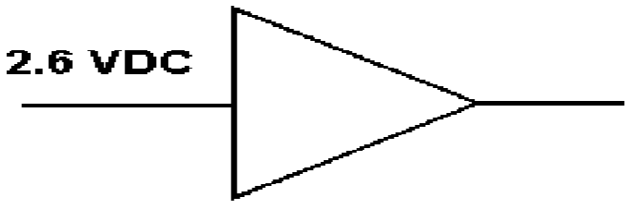
INACTIVE - VOLTAGE IS OPPOSITE FROM THE TERMINAL INDICATOR.



A = A

IN	OUT
0	0
1	1

BUFFER BOOLEAN EXPRESSION AND TRUTH TABLE



1. WHAT LOGIC SYMBOL?
2. THE GATE ON OR OFF?
3. VOLTAGE KNOWN OR UNKNOWN?

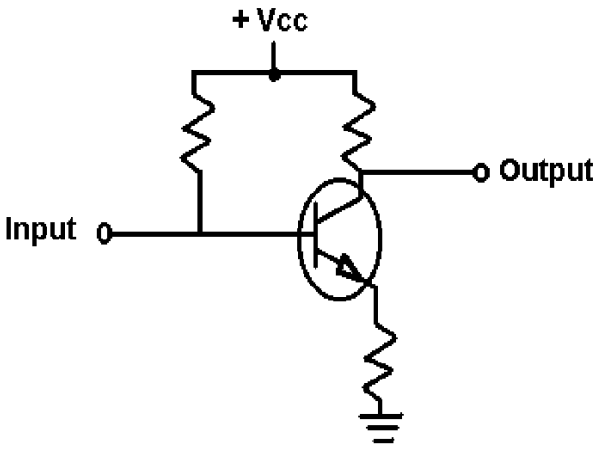
Which of the below is a Boolean expression for a Buffer?

1. $A = A$
2. $\overline{A} = A$
3. $A = A$
4. $A = AA$

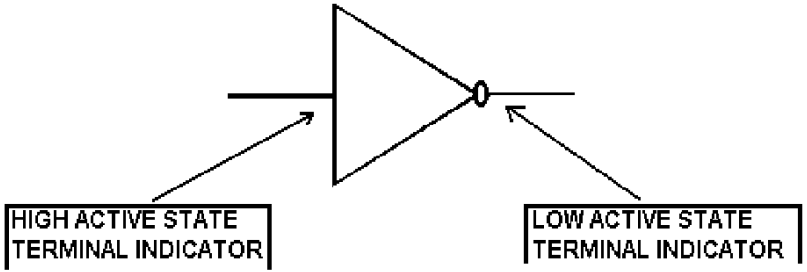
INVERTER

CHANGES OR INVERTS INPUT SIGNAL

REFER TO AS A NOT CIRCUIT OR GATE



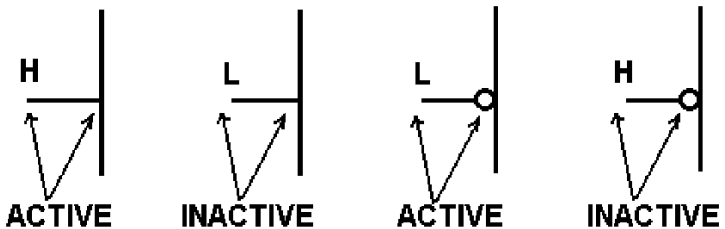
Common Emitter Inverter



Inverter Symbol and Terminal Indicators

ACTIVE - VOLTAGE IS THE SAME AS THE TERMINAL INDICATOR.

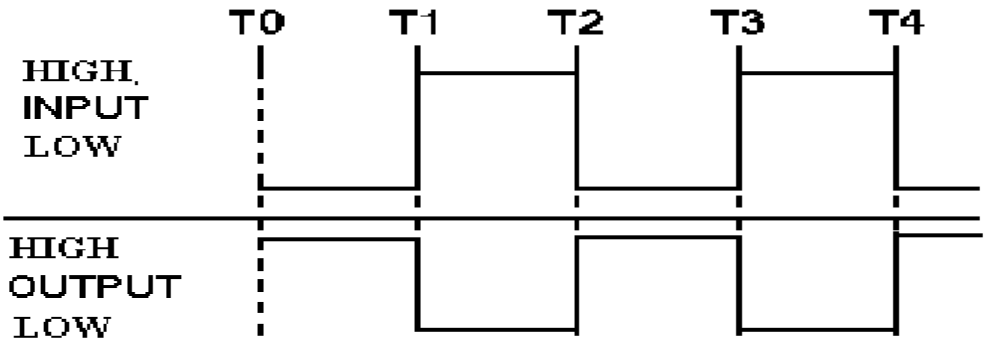
INACTIVE - VOLTAGE IS OPPOSITE FROM THE TERMINAL INDICATOR.



$A = \overline{A}$

INPUT	OUTPUT
1	0
0	1

INVERTER BOOLEAN EXPRESSION AND TRUTH TABLE



INVERTER TIMING DIAGRAM

Which of the below is a Boolean expression for a inverter?

1. $A = A$
2. $A\overline{A} = A$
3. $\overline{A = A}$
4. $A = AA$

ENABLING LEARNING OBJECTIVE 3

ACTION

Perform Theoretical Troubleshooting on digital buffer and inverter circuits.

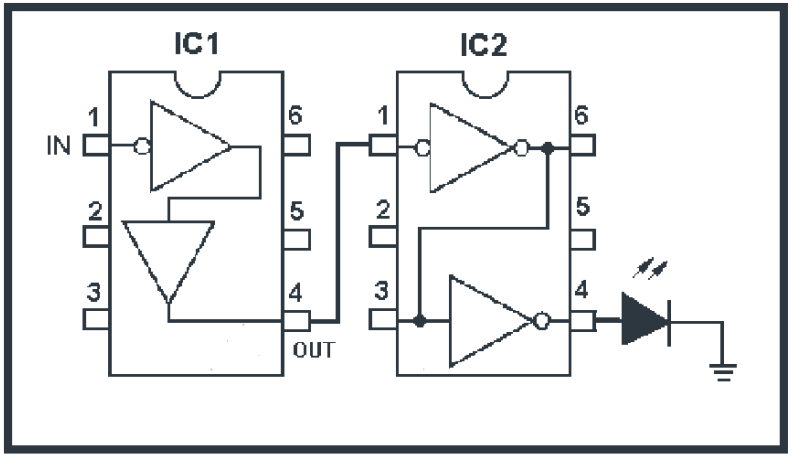
CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Logic Probe, Digital Multimeter w/test leads, PC130-106, PC130-112, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning digital buffer and inverter circuits.

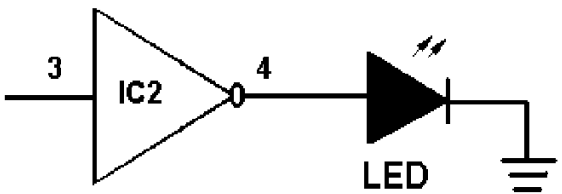
THE FOUR STEPS OF TROUBLESHOOTING	
STEP 1:	ANALYZE THE CIRCUIT
STEP 2:	RECHECK THE SET UP
STEP 3:	MEASURE AND TEST THE CIRCUIT
STEP 4:	DOUBLE CHECK THE RESULTS



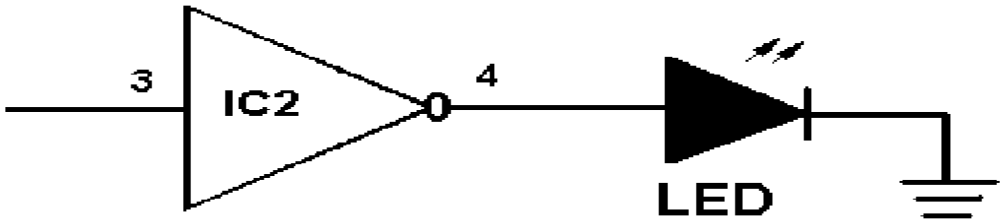
Analyze digital circuit function

EL05-S30

IC2-3	IC2-4	LED
0	1	ON
1	0	OFF

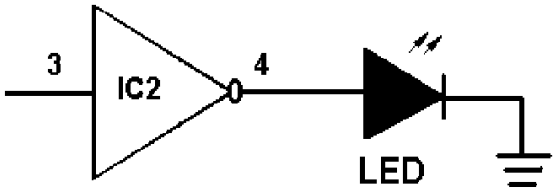


Analyze Individual Circuit Operation



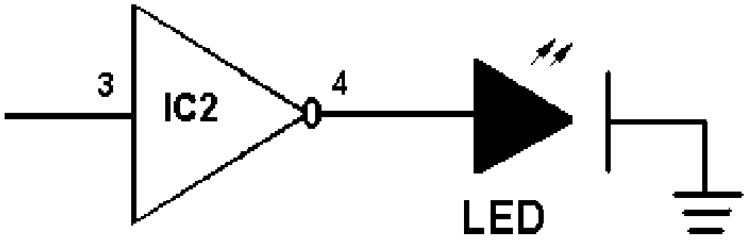
Recheck The Test Set Up

IC2-3	IC2-4	LED
0	1	OFF
1	0	OFF



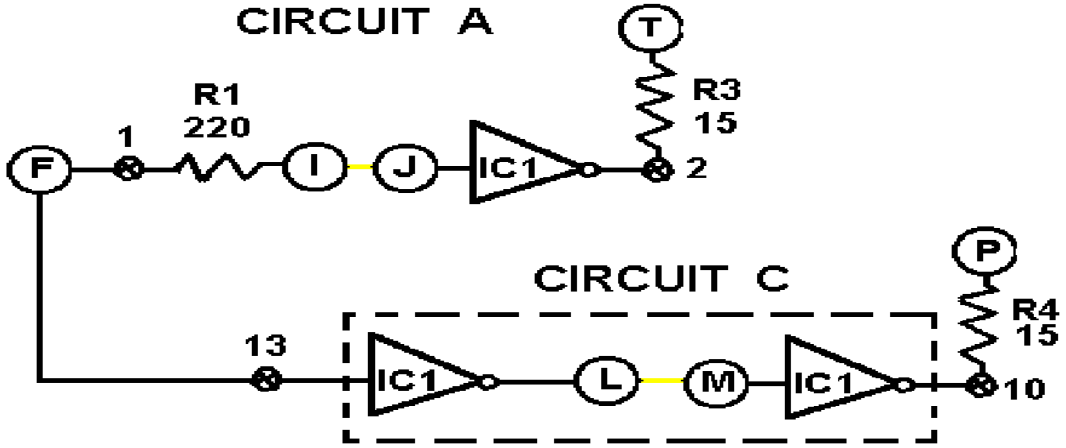
Measure And Test Faulty Circuit

EL05-S33



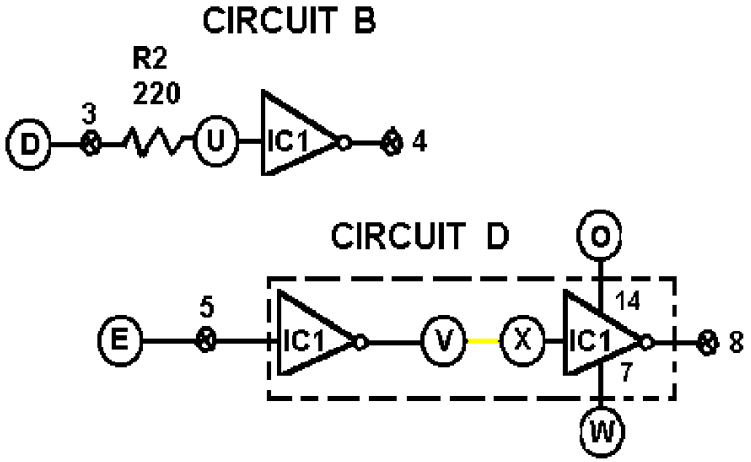
Double Check The Results

TROUBLESHOOTING DIGITAL CIRCUITS



PC130-106

EL05-S36



PC130-106 (cont)

ENABLING LEARNING OBJECTIVE 4

ACTION

Complete CAI lessons.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Logic Probe, Digital Multimeter w/test leads, PC130-106, PC130-112, and official OMEMS reference material.

STANDARD

Correctly answer 18 of 25 questions concerning digital buffer and inverter circuits.

ENABLING LEARNING OBJECTIVE 5

ACTION

Perform Troubleshooting on digital buffer and inverter circuits.

CONDITION

Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130 Electronic Trainer, Digital Logic Probe, Digital Multimeter w/test leads, PC130-106, PC130-112, and official OMEMS reference material.

STANDARD

Correctly identify 10 of 10 malfunctions on digital buffer and inverter circuits